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FIELD TRIAL OF CAFFEINE ON PHYSICAL PERFORMANCE AT ALTITUDE: AN ATTEMPT TO OVERCOME THE CHALLENGE

U S ARMY RESEARCH INSTITUTE OF ENVIRONMENTAL MEDICINE

Natick, Massachusetts

MAY 1993

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UNITED STATES ARMY
MEDICAL RESEARCH & DEVELOPMENT COMMAND

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13. ABSTRACT (Maximum 200 words)

This study was designed to determine if caffeine would enhance the physical performance of soldiers at altitude (Pikes Peak, Colo.). Eight male soldiers from Special Forces (ages 22 to 35 years old) completed two ascents of a 22 km, mountain trail (hiking from 1800 m to 4300 m above sea level) after having resided for 8 and 17 days at the summit (4300 m). Soldiers were asked to refrain from caffeinated foods and beverages for two days prior to each ascent. The composition and timing of the pre-ascent breakfasts were controlled. Ninety minutes after breakfast (one hour prior to ascent) each soldier received either caffeine (4 mg/kg body weight) or placebo in a double-blind, cross-over design. Urine samples were collected prior to each ascent for 1-methylxanthine determination. Perceived exertion, oxygen saturation, symptomatology, and "split times" were measured at selected points along the trail. None of the variables measured differed between placebo and caffeine ascents. The inability to demonstrate an improvement due to caffeine may have been due to unavoidable, confounding factors such as inclement weather on the second ascent, altitude acclimatization between ascents, and/or lack of compliance to a caffeine-free diet, as well as the small sample size.

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FIELD TRIAL OF CAFFEINE ON PHYSICAL PERFORMANCE AT ALTITUDE: AN ATTEMPT TO OVERCOME THE CHALLENGE

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Our most sincere appreciation goes to the soldiers from Special Operation Forces, members of the ODA-143 and ODA-163 Mountain Climbing Teams who volunteered for this study.

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Lastly, we would like to express our gratitude to Dr. Richard Tulley from Pennington Biomedical Research Center, Baton Rouge, La., for developing a method for the analysis of caffeine and 1-methylxanthine in urine, and analyzing the urine samples.

SUMMARY

A performance-enhancing effect of caffeine during exercise at altitude (≥ 2900 m above sea level) has been reported in the literature on two occasions. In both reports, the same individuals were tested at altitude and at sea level, and caffeine was found to improve performance at altitude but not at sea level. These findings suggest that altitude exposure amplifies the effect of caffeine on physical performance. However, one study used well-trained, cross-country skiers while the other was conducted under highly controlled laboratory conditions. The present study was designed to determine if caffeine would enhance the physical performance of soldiers in a mountain field operation (Pikes Peak, Colo.). Eight male soldiers from Special Forces (ages 22 to 35 years-old) completed two ascents of a 22 km, mountain trail (hiking from 1800 m to 4300 m above sea level) after having resided for 8 and 17 days at the summit (4300 m). Soldiers were asked to refrain from caffeinated foods and beverages for two days prior to each ascent. The composition and timing of the pre-ascent breakfasts were controlled. Ninety minutes after breakfast (one hour prior to ascent) each soldier received either caffeine (4 mg/kg body weight) or placebo in a double-blind, cross-over design. Urine samples were collected prior to each ascent for methylxanthine determination. Perceived exertion, oxygen saturation, symptomatology, and "split times" were measured at selected points along the trail. None of the variables measured differed between placebo and caffeine ascents. The inability to demonstrate an improvement due to caffeine may have been due to unavoidable, confounding factors such as inclement weather on the second ascent, altitude acclimatization between ascents, and/or lack of compliance to a caffeine-free diet, as well as the small sample size.

INTRODUCTION

Caffeine has many biochemical and physiological effects (29,37), some of which have the potential to enhance physical performance. For example, caffeine increases the rate of lipolysis stimulating the mobilization and increasing utilization of free fatty acids (2,9,10,13). Caffeine also has been reported to reduce the rate of perceived exertion (30) and to increase ventilation (28). While, some researchers have reported that caffeine enhances performance (8,10,15,18,21,22,25,28,34), others have reported no effect from caffeine (4,5,7,16,20,27,35). The reasons for the lack of agreement between studies at sea level are not readily apparent.

The effect of caffeine during exercise at moderate to high altitude (2900 m to 4300 m above sea level) has been examined twice (3,19) and both studies reported improvement in physical performance. However, in both studies, the enhanced performance at altitude occurred in individuals whose performance at sea level was not affected by caffeine administration. These results suggest that altitude exposure increases the effect of caffeine on physical performance. These findings must be viewed in light of the limitations of each of the two studies; one used well-trained, cross-country skiers (3) while the other was conducted under highly-controlled laboratory conditions (19). Thus, even though caffeine seems to aid physical performance under these conditions, further studies are needed before recommendations can be made to the military for the use of caffeine as an ergogenic aid during field operations at altitude.

OBJECTIVE

The objective of this study was to ascertain if caffeine could enhance physical performance of soldiers in a mountain field operation at Pikes Peak, Colo.

METHODS

OVERVIEW

A double-blind, cross-over study was conducted in August 1992, to determine the effect of caffeine on physical performance at altitude. Twelve volunteer soldiers ascended Pikes Peak, Colo., on two separate occasions via the Barr Trail (a distance of 22 km) which starts at an altitude of 1800 m and ends at the summit (4300 m). Ascent days' activities began at 0645 hours with collection of first morning urine for caffeine metabolites, completion of pre-ascent Environmental Symptoms Questionnaire (ESQ), consumption of a standard breakfast, and recall of the past 24-hour food intake. One hour prior to the first ascent, the volunteer soldiers were randomly assigned to either a caffeine (4 mg/kg body weight) or placebo group. One hour prior to the second ascent, each soldier received the opposite regimen. Elapsed time and perceived exertion were recorded at midpoint (Barr Camp 3100 m altitude), at about 2 km from the summit, and at the summit. Additionally, at the summit, overall perceived exertion and oxygen saturation were recorded. The soldiers completed a post-ascent ESQ and were also asked if they thought they had received caffeine or placebo drink. Approximately 4 hours after each ascent was completed, the soldiers completed another ESQ.

VOLUNTEERS

Twelve male soldiers from Special Operation Forces, members of the ODA-143 and ODA-163 Mountain Climbing Teams, volunteered for this study. Each soldier underwent a medical history and a physical examination, and none was found to have any contraindications to caffeine or altitude exposure. After the soldiers were informed of the procedures, risks, and benefits of the study, they provided written consent by signing a Volunteer Agreement Affidavit.

The soldiers were part of a larger study which required that they reside in the U.S. Army Research Institute of Environmental Medicine Pikes Peak Laboratory at the summit (4,300 m). The soldiers were transported down to the beginning of the Barr Trail by automobile, immediately before each ascent.

The soldiers' ages ranged from 22 to 35 years (Table 1). Soldiers' weight at the time of each of the two ascents, habitual caffeine intake (determined by a questionnaire, Appendix A), and smoking/tobacco habits are also shown in Table 1.

Table 1. Habitual Caffeine Intake and Smoking (Tobacco) Habits

		Ascent 1	Ascent 2	Habitual		
Soldier #	Age	Weight (kg)	Weight (kg)	Caffeine (mg/d)	Cigarettes (per day)	Smokeless Tobacco
1	32	75.0	72.3	164.3	0	N
2	23	66.8	65.9	539.2	20	N
3	28	70.4	69.1	48.5	0	N
4	31	91.4	90.9	821.8	0	Y
5	29	94.5	93.6	208.3	20	N
6	35	78.2	76.8	77.9	0	N
7	29	78.2	75.9	286.7	0	Y
8	32	90.5	-	261.2	0	-
9	25	63.0	69.5	33.0	0	N
10	28	74.5	79.1	28.9	0	Y
11	22	90.7	89.1	5.6	0	N
12	35	85.8	86.4	6.4	0	N

PROCEDURES

In the original study plans, the volunteer soldiers were scheduled to ascend on the 8th and 11th day of residing at altitude. However, the second ascent had to be postponed to the 17th day due to inclement weather. Two days prior to each ascent, the soldiers were provided with verbal and written information on caffeine-containing foods and beverages, and were instructed to avoid those items until after the ascents.

On the morning of each ascent, the soldiers consumed a standard breakfast and, one hour prior to the subsequent ascent, consumed a 250 mL caffeine (4 mg/kg body weight) or placebo drink in 30 seconds or less. The soldiers were then driven down to the beginning of the Barr Trail. Each ascent began at approximately 1015 hours. The soldiers were not allowed to take watches, were requested to wear the same amount of clothing, and carry the same amount of gear on both occasions. Since the Barr Trail is fairly narrow, soldiers were released in random order from the "starting line" in one minute increments. The soldiers were encouraged to hike up as quickly as possible and avoid competing with each other. For safety and recording of data, members of the research team were located at various sites along the trail.

Standard Breakfast

All soldiers were offered the same breakfast (Appendix B) at 0700 hours, three hours prior to each ascent. The breakfast provided approximately 1200 kilocalories with a macronutrient distribution of 50% carbohydrate, 15% protein, and 35% fat. The soldiers were required to eat the entire breakfast.

Placebo and Caffeine Drinks

The placebo drink appeared identical and tasted similar to the caffeine drink. Both drinks were prepared by the medical monitor using the following recipes:

Placebo Drink

2 qt Water
4 Tbsp Tea mix
(unsweetened decaffeinated)
4 pkg Sweet and Low[1]

Caffeine Drink

2 qt Water
4 Tbsp Tea mix
(unsweetened decaffeinated)
2 pkg Sweet and Low[1]
2600 mg Caffeine[2] powder
2 pkg Equal[1]

---

[1]Citation of brand names does not constitute endorsement of the products.

[2]Caffeine Anhydrous, Product No. C0750 FD, Lot No. 84F0801 FD. Sigma F and D Division, Ltd.

The caffeine drink contained 40 mg caffeine/oz of fluid (1.35 mg caffeine/mL of fluid). To determine the amount of fluid ounces needed to provide a caffeine dose equal to 4 mg/kg body weight, the body weight of each soldier was multiplied by 4 mg/kg and the product was then divided by 40 mg/oz.

The drinks were allocated to the soldiers by the medical monitor as indicated in Table 2. Neither the soldiers nor the other members of the research team knew who was receiving the caffeine until after both ascents were completed.

Table 2. Caffeine Dosing Schedule

Soldier #	Ascent 1	Ascent 2
1	Placebo	-
2	Caffeine	Placebo
3	Placebo	Caffeine
4	Caffeine	Placebo
5	Placebo	-
6	Caffeine	-
7	Placebo	Caffeine
8	Caffeine	-
9	Placebo	Caffeine
10	Caffeine	Placebo
11	Placebo	Caffeine
12	Caffeine	Placebo

"-" denotes soldiers who did not complete the first ascent successfully (soldiers #1, #5 and #6 strayed from the Barr Trail, and soldier #8 developed High Altitude Pulmonary Edema).

DATA COLLECTION

A summary of the data collection schedule is depicted in Table 3. Data collection was identical for both ascents.

Table 3. Schedule of Ascent Days

Activity	Time of Day (24-hour mode)													
	0645	0700	0730	0800	0830	0900	0930	1000		*	**	***		2000
Urine Sample	X													
ESQ	X											X		X
Body Weight	X													
Std Breakfast		X												
Food Record			X											
Dosing						X								
Begin Ascent								X						
Elapsed Time										X	X	X		
Perceived Exertion										X	X	X		
Oxygen Saturation												X		
Perceived Caffeine												X		

* Midpoint (11 km)
** 2 km from summit
*** End (22 km)

Urine Sample

Urine samples (first morning void) provided by the soldiers on the morning of each ascent were frozen and shipped to Pennington Biomedical Research Center, Baton Rouge, La., where they were analyzed for caffeine and 1-methylxanthine. These samples were deproteinized and filtered. Then, 10 μL of filtrate was injected into a Hewlett Packard 1090M

High Performance Liquid Chromatography system equipped with a Water's Bondapack C18 column (10 µm, 3.9 x 300 mm). Flow was at 1.8 mL/min; detection was at 272 nm.

Food Record (24-hours)

To assess nutritional intake on the day preceding each ascent, each soldier completed a 24-hour food record in which they listed all foods and fluids consumed during the preceding day. A registered dietitian reviewed each food record with the respective soldier to clarify/verify intakes and portion sizes.

Nutrient Intakes. Nutrient (carbohydrate, protein, and fat), energy, and fluid intakes for the day preceding each ascent were determined using the Computerized Analysis of Nutrients (CAN) System (31).

Elapsed Hiking Time

Elapsed time during the ascents were calculated from actual times of day recorded at midpoint, 2 km from the summit, and at the summit by members of the research team using previously synchronized wrist watches.

Perceived Exertion

Ratings of perceived exertion were obtained from each soldier during each ascent using the Borg scale (6). The Borg scale consists of a 15-point continuous scale from 6 to 20 with each odd number anchored by a verbal expression of difficulty ranging from "very, very light" to "very, very hard" (Appendix C). Each soldier's perceived exertion was assessed at midpoint, 2 km from the summit, and at the summit. Soldiers were also asked to rate their overall perceived exertion for each ascent.

Oxygen Saturation

Immediately upon reaching the summit, each soldier's arterial oxygen saturation was measured noninvasively using a pulse oximeter (Sensormedics, Inc.), attached to a finger.

Perceived Treatment

At the completion of each ascent, each soldier was asked if they thought they had received the caffeine or placebo drink that day.

Environmental Symptoms Questionnaire

The ESQ (Appendix D) is a 67-item inventory designed to quantify symptoms induced by altitude and other stressful environments (32,33). The ESQ was self-administered three times each ascent day. The pre-ascent ESQ (administered before breakfast) was used to assess Acute Mountain Sickness (AMS) symptomatology before each ascent. Two ESQs were administered post-ascent (one immediately after each ascent and the other four hours after each ascent) to assess symptoms of exertion, muscular discomfort, fatigue, and mountain sickness induced by the rapid ascent (32,33). The soldiers rated the severity of symptoms on a 6-point scale ranging from 0 = "not at all" to 5 = "extreme."

STATISTICAL ANALYSIS

Data were statistically analyzed using SPSS-X (36) on a Digital Equipment Corporation VAX 6510. Paired t-tests were used to analyze all data (except ESQ). ESQ data were analyzed using a two-way ANOVA with repeated-measures on 2 factors: main factors were time of ESQ administration (pre-ascent, post-ascent, 4 hours post-ascent) and treatment (caffeine, placebo). All values reported are means ± SEM unless otherwise stated. The level of significance chosen was $p \leq 0.05$.

RESULTS

OVERVIEW

Although the first ascent was initiated with 12 volunteer soldiers, three strayed from the Barr Trail and one developed High Altitude Pulmonary Edema (HAPE) requiring immediate withdrawal from the study. Thus, the data presented were obtained from the 8 soldiers who successfully completed both ascents. Food recall data indicate similar nutrient intakes for the 24 hours preceding each ascent. Urine analyses showed that some of the soldiers did not abstain from consuming caffeine-containing foods and beverages for the days preceding each ascent. Caffeine did not have a significant effect on elapsed time, perceived exertion, or oxygen saturation. Muscular discomfort and fatigue were less for the caffeine group, but these were not statistically significant.

URINE ANALYSIS

Mean urinary 1-methylxanthine was similar for placebo and caffeine groups, 25.40 ± 8.34 µL and 26.93 ± 5.56 µL, respectively. Urinary 1-methylxanthine and caffeine data are presented in Table 4.

FOOD RECORD

Food record data indicate that the soldiers' intakes of carbohydrate, protein, fat, energy, and fluid for the 24 hours preceding each ascent were similar (Figure 1).

ELAPSED HIKING TIME AND PERCEIVED EXERTION

Elapsed hiking time and perceived exertion were not statistically different between placebo and caffeine at the midpoint, 2 km from the summit, or at the summit (Table 5).

Table 4. Urinary 1-Methylxanthine and Caffeine Before Consuming Placebo or Caffeine Drink

	Placebo		Caffeine	
Soldier #	**1-Methylxanthine (µL/mL)**	**Caffeine (µL/mL)**	**1-Methylxanthine (µL/mL)**	**Caffeine (µL/mL)**
2	34.3	3.3	45.2	8.9
3	8.0	0.2	11.9	2.7
4	59.6	1.6	50.3	0.8
7	11.0	0.1	22.3	0.5
9	0.2	0.2	38.0	1.9
10	4.9	0.4	16.6	11.9
11	26.9	0.4	8.0	0.0
12	58.3	0.7	23.1	0.0

Figure 1. Food Record Data

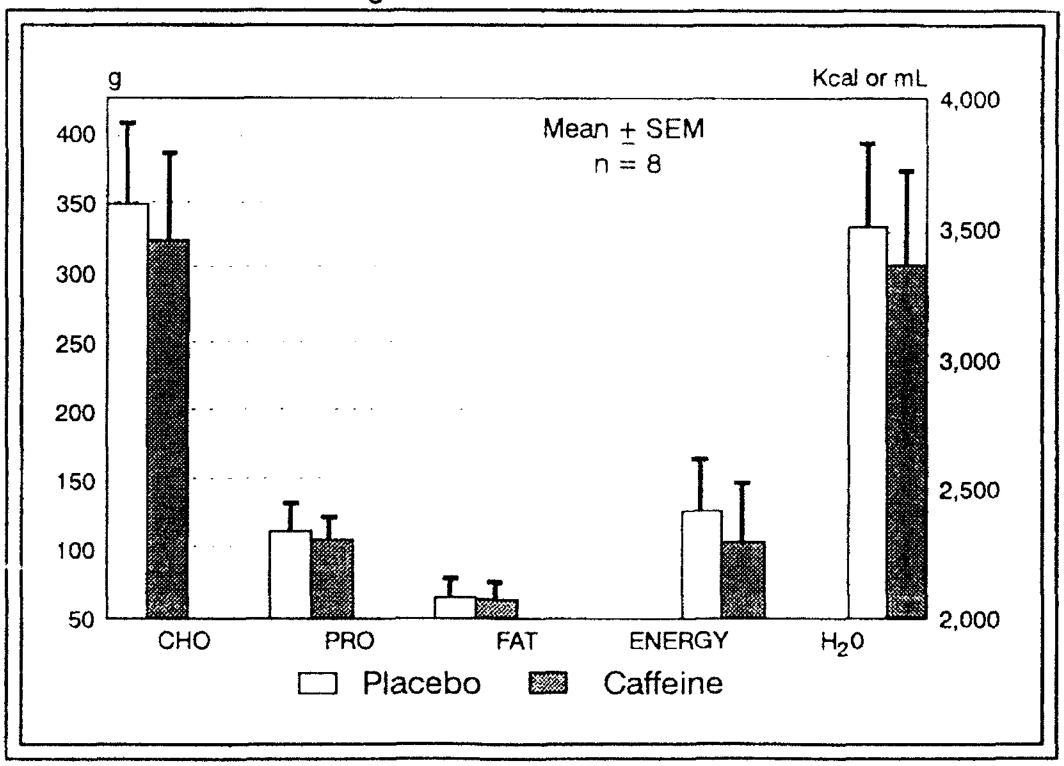


Table 5. Elapsed Time and Perceived Exertion

		Split Time[1] (Hours)	Perceived Exertion[1] (Borg Scale)[2]
Midpoint	Placebo	1.67 ± 0.11	13.13 ± 1.16
	Caffeine	1.81 ± 0.05	13.63 ± 0.68
	p	0.260	0.705
2 km from Summit	Placebo	3.57 ± 0.17	14.38 ± 1.12
	Caffeine	3.49 ± 0.11	14.63 ± 1.00
	p	0.446	0.815
Summit	Placebo	4.53 ± 0.22	14.71 ± 1.84
	Caffeine	4.41 ± 0.13	13.29 ± 1.71
	p	0.443	0.472
Overall	Placebo	-	15.30 ± 1.44
	Caffeine	-	13.25 ± 1.24
	p	-	0.872

[1]Mean ± SEM.

[2]A 15-point continuous scale from 6 to 20 with each odd number anchored by a verbal expression of difficulty ranging from "very, very light" to "very, very hard."

When the first ascent was compared to the second ascent (independent of placebo or caffeine administration), the overall perceived exertion on the second ascent was significantly lower (14.5 ± 0.9 and 12.13 ± 0.8, $p \leq 0.05$).

OXYGEN SATURATION

Arterial oxygen saturation was not significantly different between the two groups (62.5% ± 2.9% and 68.3% ± 4.2%, p=0.203 for placebo and caffeine, respectively). There was no correlation of arterial oxygen saturation with overall perceived exertion (r=0.0272, p=0.474 for the placebo group and r=-0.3859, p=0.173 for the caffeine group).

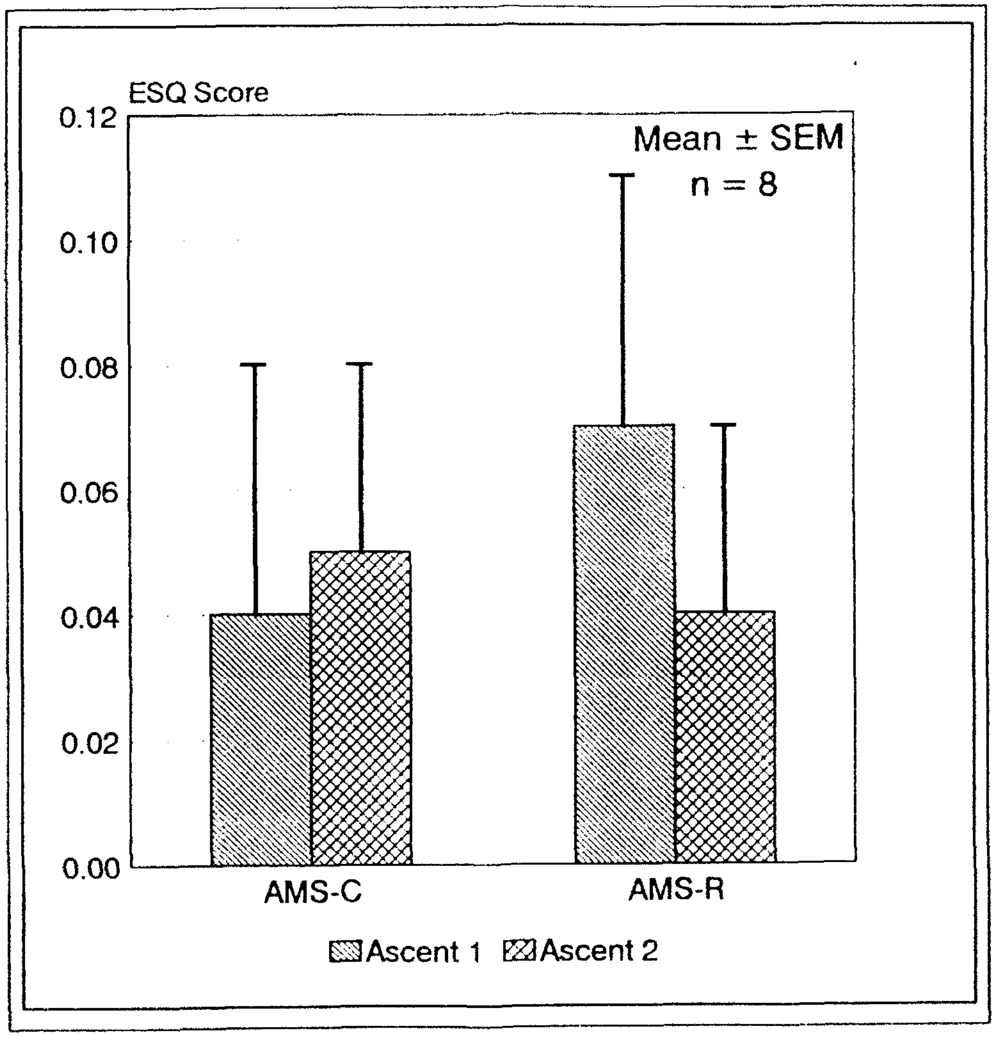
PERCEIVED TREATMENT

Five out of eight soldiers on the first ascent and six out of eight soldiers on the second ascent accurately perceived receiving caffeine or placebo. For each ascent, one soldier was undecided.

ENVIRONMENTAL SYMPTOMS QUESTIONNAIRE

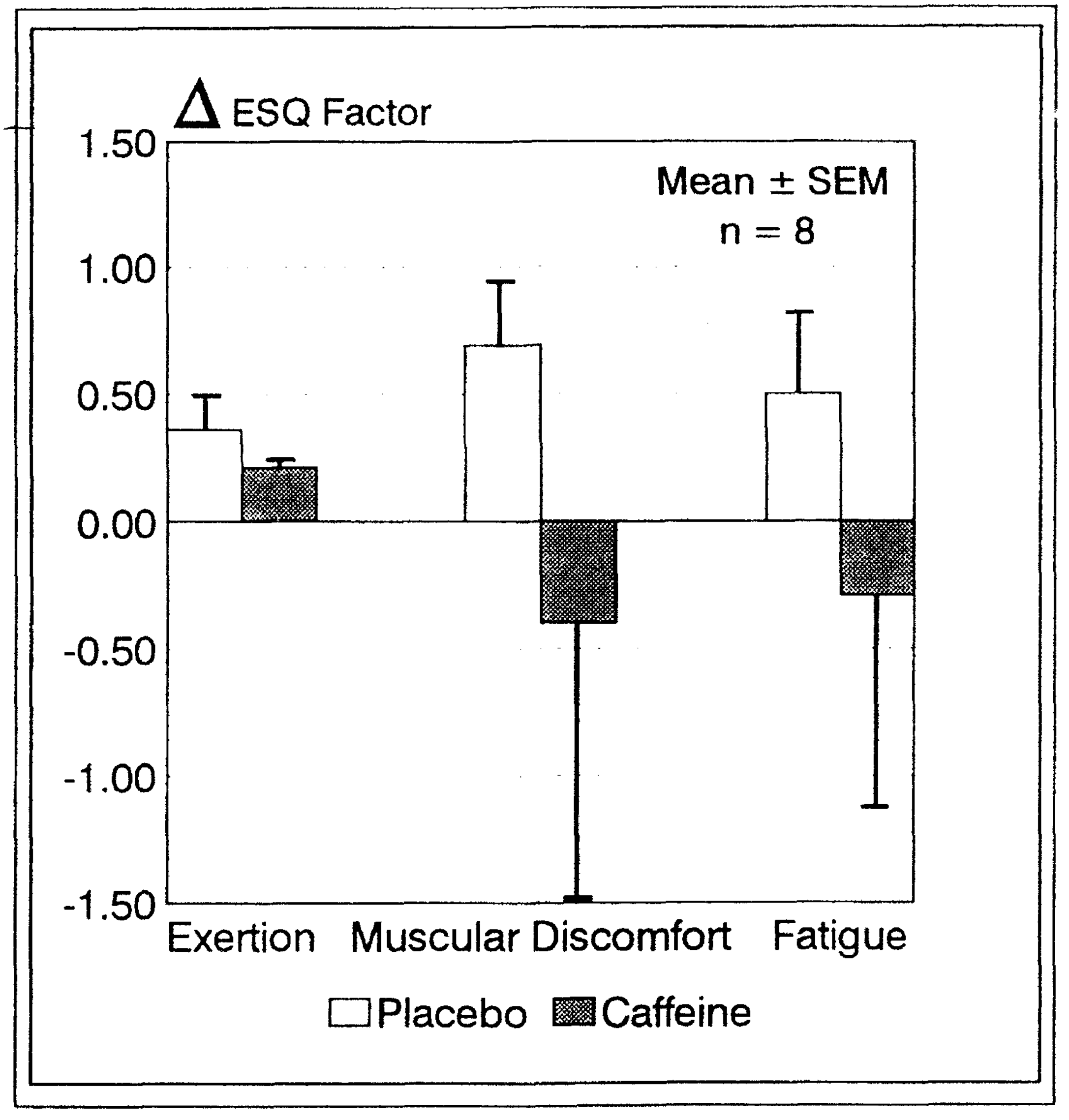
Pre-ascent AMS factor scores (cerebral: AMS-C and respiratory: AMS-R) data indicate there was little AMS symptomatology (Figure 2).

Figure 2. Pre-Ascents Environmental Symptoms Factor Scores



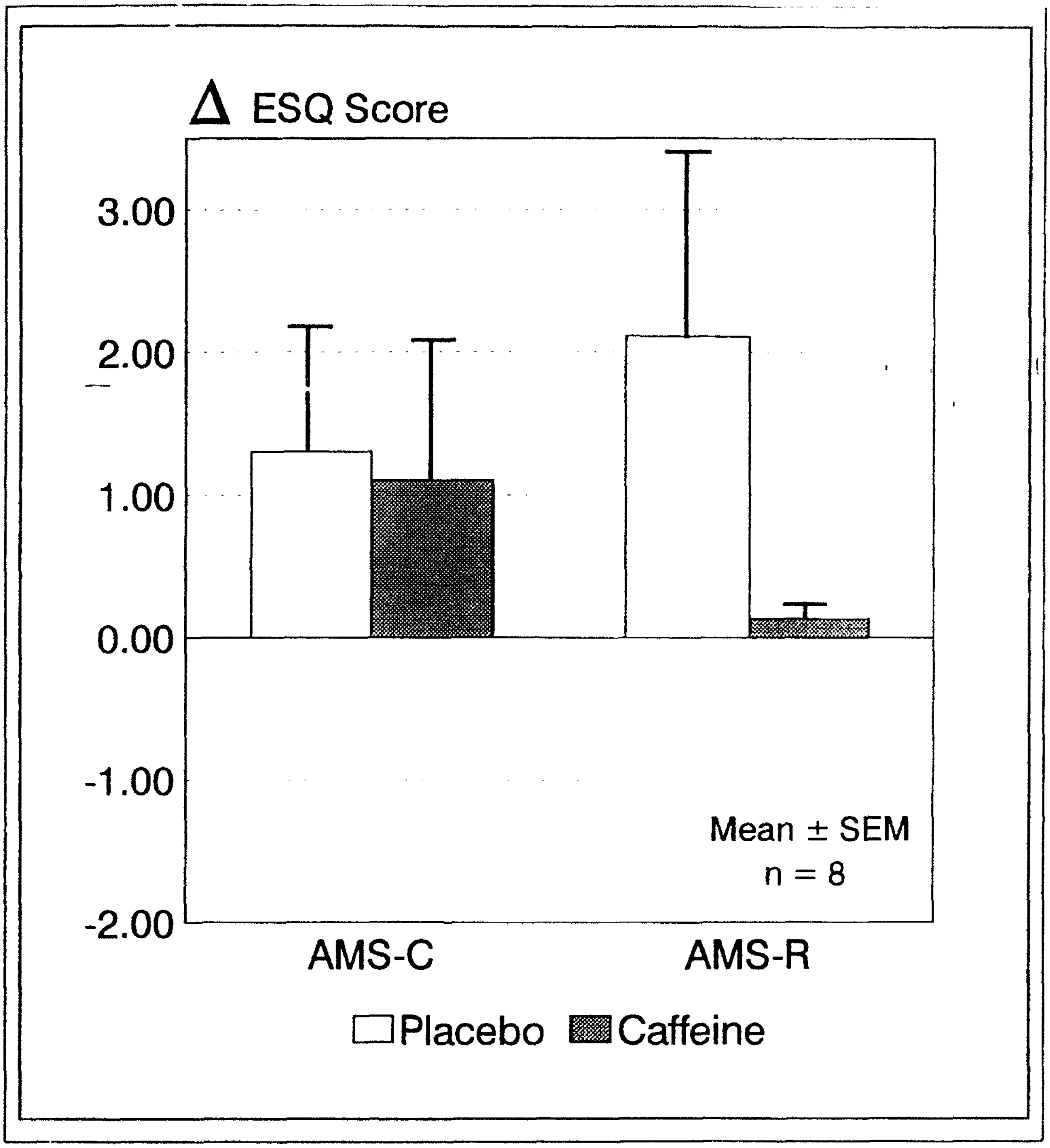
Exertion, muscular discomfort, and fatigue factor scores were used to characterize the change in difficulty of effort from placebo to caffeine treatments (Figure 3). Although muscular discomfort and fatigue were reduced during caffeine treatment, the difference was not statistically significant. Post-ascent AMS-C and AMS-R factor scores are illustrated in Figure 4. Both factor scores were reduced during caffeine treatment, but because of the large intra-individual variation, this difference was not statistically significant.

Figure 3. Change[1] in Difficulty of Effort Before and After Ascents



[1]Change in difficulty of effort = (symptom scores after ascents - symptom scores before ascents).

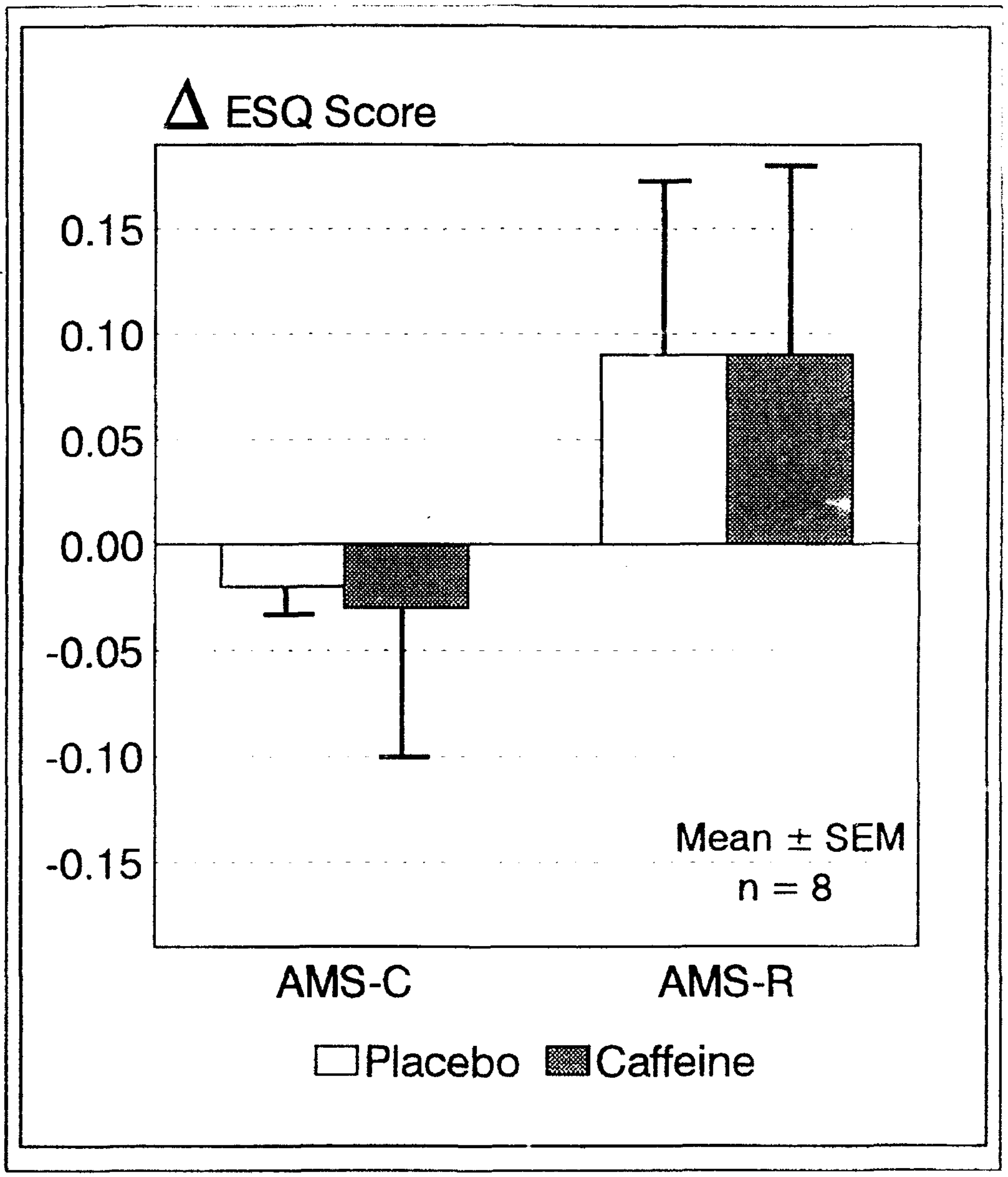
Figure 4. Change[1] in ESQ Factor Scores Before and After Ascents



[1]Change in ESQ factor scores = (factor scores after ascents - factor scores before ascents).

Figure 5 shows the change in AMS-C and AMS-R factor scores between the placebo and caffeine treatments before and four hours after each ascent. There were no statistical differences.

Figure 5. Change[1] in ESQ Factor Scores Before and Four Hours After Ascents



[1]Change in ESQ factor scores = (factor scores four hours after ascents - factor scores before ascents).

DISCUSSION

The reasons for the lack of agreement between prior studies attempting to demonstrate an effect of caffeine on physical performance are not readily apparent. Any factor that affects caffeine's metabolism could be implicated. Furthermore, differences in dosage, type of task (performance measurement), and subjects' fitness level and nutritional status could explain, in part, the disagreement among studies (4,5,7,8,10,15,16,18,20-22,25,27,28,34,35). Interpretation of results is confined and limited by these factors. Thus, careful study design is of utmost importance to obtain valid results. However, while highly controlled studies are ideal, they may not adequately represent field scenarios.

In the present study, we attempted to limit the variability of many factors by using a double-blind, cross-over design. We controlled nutritional intake prior to each ascent (11,14,23,28), recorded dietary intake (to estimate nutritional intakes) for 24 hours preceding each ascent, and determined habitual caffeine intake and smoking habits. We also attempted to limit caffeine intake by instructing the volunteer soldiers to avoid caffeine-containing foods and beverages for two days preceding each ascent. However, the results of this study are equivocal due to various confounding factors.

The first confounding factor was differences in weather and trail conditions between the two ascents that, in our opinion, the cross-over design could not control. During the second ascent, the last 3 km of the Barr Trail, (which is the steepest and most difficult part of the trail), was covered with packed snow, and the soldiers reported having difficulty trying to get traction. However, if trail conditions were the only cause for no difference between ascents, then one would expect that, if caffeine were beneficial, then the midpoint "split time" for the caffeine group would have been less than for the placebo group since midpoint results should not have been influenced by the changes in terrain conditions 9 km farther up the trail. However, caffeine did not appear to enhance performance time for the first part of the trail (11 km; hiking from 1800 m to 3100 m above sea level).

Berglund and Hemmingsson (3) had a somewhat similar problem and used a normalization procedure to minimize the differences in weather and snow conditions from one downhill ski trial to another. They assumed that caffeine would have the same effect in each descent regardless of climatic conditions. The individual's time for each descent was

reported in terms of a percentage from the group mean time for each descent, respectively. Then, the individual difference in time between the placebo and caffeine descent was determined and analyzed. Normalizing our data using their procedure showed a mean difference of 2.47 percent, (i.e., caffeine's time was shorter, though not statistically significant).

Other potentially confounding factors were differences in habitual caffeine consumption (1,12,17) and smoking habits (26) which have been shown to alter caffeine metabolism. However, reanalyzing the data not using those soldiers who were heavy caffeine users (soldiers #2, #4, and #7) and smokers/chewers (soldiers #2, #4, #7, and #10) still showed that caffeine did not have a beneficial effect on physical performance. However, eliminating these soldiers causes the remaining sample size of four soldiers to be too small to detect statistically significant differences or to make any meaningful comparisons.

The soldiers had similar amounts of baseline caffeine before each ascent. Thus differences in baseline values of caffeine can not be a confounding factor. However, the levels of baseline urinary 1-methylxanthine and caffeine were higher than expected, suggesting poor compliance with study requirements and reducing the probability of detecting an effect of additional caffeine.

Inclement weather, unfortunately, increased the days between ascents from the planned 3 days to 9 days, thus increasing soldiers' length of time residing at altitude. Therefore, the difference in rate of perceived exertion between the first and second ascent (independent of placebo or caffeine administration) could have been caused by a difference in soldiers' acclimatization. Even though pre-ascent ESQ results indicate that the soldiers were free from AMS symptoms prior to each ascent, they were probably acclimatized to a greater extent for the second ascent. A prior altitude study (19) suggests that the effects of caffeine are lessened with prolonged altitude exposure. If so, then the variability associated with comparing a period of time in which caffeine would likely be beneficial (8 days) to a period of time caffeine would likely not be beneficial (17 days) would be greater than any expected enhancement of caffeine. Another reason could be that the trail familiarization that occurred during the first ascent caused perceived exertion to be less the second time around. Further, environmental temperature and relative humidity were lower during the second ascent which could have influenced perceived exertion.

At high altitude, physical work capacity is decreased due to the lower barometric pressure and subsequent reduction in oxygen content of arterial blood. A previous report, with less confounding factors than the present study (19), showed caffeine improved physical performance at altitude. That report suggests that the improvement in performance was related to a caffeine-induced increase in arterial oxygen saturation, (i.e., increased arterial oxygen content). During the present study, arterial oxygen saturation was measured only once, immediately upon reaching the summit. Although not statistically significant, arterial oxygen saturation tended to be higher during the caffeine ascents, in agreement with the previous findings of the laboratory-based study (19).

If caffeine is used as an ergogenic aid in military situations, then caffeine abstinence (as attempted in this study) prior to each operation might not be always feasible or desirable (because of personal preference or withdrawal symptoms). The results obtained in this study might represent a true estimate of what to expect when caffeine is used as an ergogenic aid for soldiers. These results suggest that a dosage of 4 mg/kg of body weight may be too small to enhance physical performance on soldiers who habitually consume caffeine.

CONCLUSIONS

Although caffeine appeared not to have an effect on physical performance at altitude, the results of this study are not conclusive due to various confounding factors such as inclement weather, lack of compliance to a caffeine-free diet, and significant differences in acclimatization, that could have "masked a beneficial effect of caffeine." For these reasons, it can not be concluded that caffeine would not be beneficial at altitude. Clearly, more research, under more controllable conditions, is needed to determine the effects of caffeine on physical performance at altitude.

RECOMMENDATIONS

Future caffeine studies should employ the following design features, in addition to the variables controlled for in this study:

1. The individuals should be made familiar with the performance tasks required in the study.
2. A larger sample size should be studied to allow for the separation of habitual caffeine users (light versus heavy).
3. Larger caffeine dosages should be considered.

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APPENDICES

APPENDIX A

Caffeine Consumption Frequency Questionnaire

	YOUR SERVING		NUMBER OF TIMES	PER
COFFEE			none 1 2 3 4 5 6 7	day week month year
Brewed	cup	mug		
instant	cup	mug		
MRE Coffee	1 package			
TEA			none 1 2 3 4 5 6 7	day week month year
Brewed	cup	mug		
Instant	cup	mug		
Iced Tea	8oz	12oz		
Ration Tea	1 package			
COCOA			none 1 2 3 4 5 6 7	day week month year
Chocolate Milk	cup	mug		
Cocoa/Hot Chocolate	cup	mug		
MRE Cocoa Mix	1 package			
CANDY			none 1 2 3 4 5 6 7	day week month year
Milk Chocolate	1 ounce			
Dark Chocolate	1 ounce			
Other Candy______	______			
MRE M&M	1 package			
Ration Brownie	1 package			
SOFT DRINKS			none 1 2 3 4 5 6 7	day week month year
Cola-Type	12oz	16oz		
Dr. Pepper	12oz	16oz		
Mr. PIBB	12oz	16oz		
Big Red	12oz	16oz		
Mountain Dew	12oz	16oz		
Mello Yello	12oz	16oz		

Please indicate which of these medications you take regularly (two or more times per week.)

No Doz	Excedrin	Soma Compound
Vivarin	Coryban-D	Darvon Compound
Aspirin	Dristan	Weight Control Aids
Anacin	Triaminicin	Other______

APPENDIX B

Standard Breakfast for Ascent Days

Menu	Serving	Energy Kcal	CHO g	PRO g	FAT g
Orange Juice	8 oz	120	30	-	-
Eggs, Scrambled	3/4 cup	225	-	21	15
Toast, White	2 ea	160	30	6	-
Muffin, Blueberry[1]	1 ea	280	46	6	8
Margarine	3 tsp (15 g)	135	-	-	15
Total Raisin Bran[2]	1.5 oz (1 c)	140	33	3	1
Milk, 2% Low Fat	8 oz	125	12	8	5
Total		**1185**	**151**	**44**	**44**
Goal		1200	150	45	47

[1]Dunkin Donuts
[2]General Mills

APPENDIX C

Perceived Exertion Scale

6
7 VERY, VERY LIGHT
8
9 VERY LIGHT
10
11 FAIRLY LIGHT
12
13 SOMEWHAT HARD
14
15 HARD
16
17 VERY HARD
18
19 VERY, VERY HARD
20

APPENDIX D

Environmental Symptoms Questionnaire

INSTRUCTIONS: Circle each item separately to indicate whether you DO or DO NOT have the symptom at this moment. PLEASE READ EACH ITEM CAREFULLY.

	NOT AT ALL	SLIGHT	SOMEWHAT	MODERATE	QUITE A BIT	EXTREME
1. I feel lightheaded	0	1	2	3	4	5
2. I have a headache	0	1	2	3	4	5
3. I feel sinus pressure	0	1	2	3	4	5
4. I feel dizzy	0	1	2	3	4	5
5. I feel faint	0	1	2	3	4	5
6. My vision is dim	0	1	2	3	4	5
7. My coordination is off	0	1	2	3	4	5
8. I'm short of breath	0	1	2	3	4	5
9. It's hard to breathe	0	1	2	3	4	5
10. It hurts to breathe	0	1	2	3	4	5
11. My heart is beating fast	0	1	2	3	4	5
12. My heart is pounding	0	1	2	3	4	5
13. I have chest pains	0	1	2	3	4	5
14. I have chest pressure	0	1	2	3	4	5
15. My hands are shaking or trembling	0	1	2	3	4	5
16. I have muscle cramps	0	1	2	3	4	5
17. I have stomach cramps	0	1	2	3	4	5
18. My muscles feel tight or stiff	0	1	2	3	4	5
19. I feel weak	0	1	2	3	4	5
20. My legs or feet ache	0	1	2	3	4	5
21. My hands, arms or shoulders ache	0	1	2	3	4	5
22. My back aches	0	1	2	3	4	5
23. I have a stomach ache	0	1	2	3	4	5
24. I feel sick to my stomach (nauseous)	0	1	2	3	4	5
25. I have gas pressure	0	1	2	3	4	5
26. I have diarrhea	0	1	2	3	4	5
27. I'm constipated	0	1	2	3	4	5
28. I have to urinate MORE than usual	0	1	2	3	4	5
29. I have to urinate LESS than usual	0	1	2	3	4	5
30. I feel warm	0	1	2	3	4	5
31. I feel feverish	0	1	2	3	4	5
32. My feet are sweaty	0	1	2	3	4	5

(Continue Over)

NATICK FORM 1432
1 FEB 90

	NOT AT ALL	SLIGHT	SOMEWHAT	MODERATE	QUITE A BIT	EXTREME
33. I'm sweating all over	0	1	2	3	4	5
34. My hands are cold	0	1	2	3	4	5
35. My feet are cold	0	1	2	3	4	5
36. I feel chilly	0	1	2	3	4	5
37. I'm shivering	0	1	2	3	4	5
38. Parts of my body feel numb	0	1	2	3	4	5
39. My skin is burning or itchy	0	1	2	3	4	5
40. My eyes feel irritated	0	1	2	3	4	5
41. My vision is blurry	0	1	2	3	4	5
42. My ears feel blocked up	0	1	2	3	4	5
43. My ears ache	0	1	2	3	4	5
44. I can't hear well	0	1	2	3	4	5
45. My ears are ringing	0	1	2	3	4	5
46. My nose feels stuffed up	0	1	2	3	4	5
47. I have a runny nose	0	1	2	3	4	5
48. I've been having nose bleeds	0	1	2	3	4	5
49. My mouth is dry	0	1	2	3	4	5
50. My throat is sore	0	1	2	3	4	5
51. I've been coughing	0	1	2	3	4	5
52. I've lost my appetite	0	1	2	3	4	5
53. I feel sick	0	1	2	3	4	5
54. I feel hungover	0	1	2	3	4	5
55. I'm thirsty	0	1	2	3	4	5
56. I feel tired	0	1	2	3	4	5
57. I feel sleepy	0	1	2	3	4	5
58. I couldn't sleep well	0	1	2	3	4	5
59. My concentration is off	0	1	2	3	4	5
60. I'm more forgetful lately	0	1	2	3	4	5
61. I feel worried or nervous	0	1	2	3	4	5
62. I feel irritable	0	1	2	3	4	5
63. I feel restless	0	1	2	3	4	5
64. I'm bored	0	1	2	3	4	5
65. I feel depressed	0	1	2	3	4	5
66. I feel alert	0	1	2	3	4	5
67. I feel good	0	1	2	3	4	5

Comments: ______________________________

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